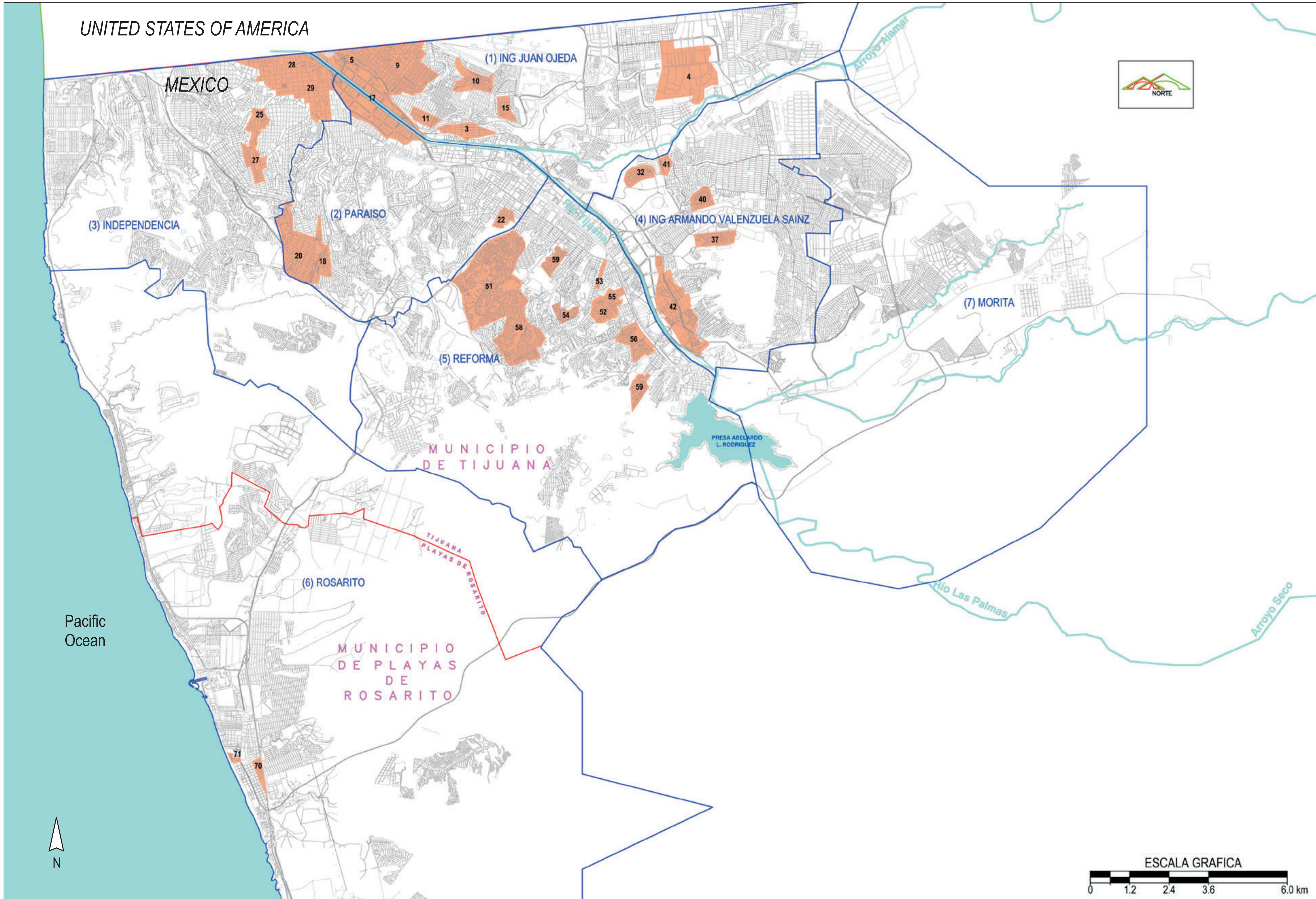

Legend

- Urban area
- Municipal limit
- Major streams
- District limit
- Body of water
- Recurring leaks

No. Name of each neighborhood (The numbers correspond to the neighborhoods listed in appendix G, table G-1)

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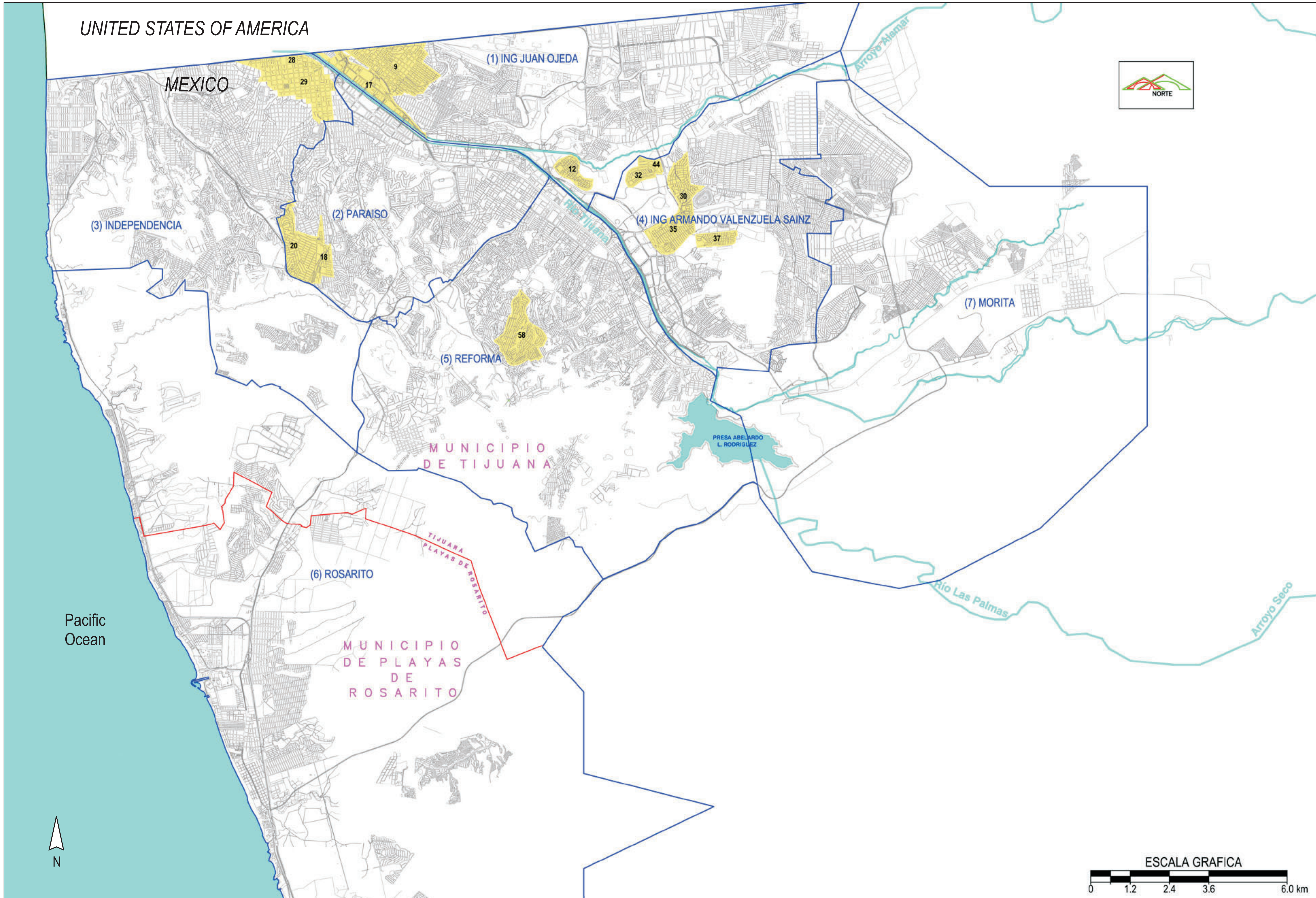
Figure 3-16
Areas with recurring leaks



Legend

- Urban area
- Municipal limit
- Major streams
- District limit
- Body of water
- Areas requiring immediate rehabilitatoin

No. Name of each neighborhood (The numbers correspond to the neighborhoods listed in appendix G, table G-1)

CDM

Figure 3-17
Areas requiring immediate rehabilitation

The short-term proposals for alternatives include providing service to the areas that currently do not have any, especially in the *colonias* (neighborhoods) not included in the Japanese Credit Report. Additionally, recommendations will be offered to address the existing deficiencies in the *colonias* (neighborhoods) that have service, but do not meet the required water quality.

3.3.2 Condition and Capacity (State of the Infrastructure)

General Description

In the study area, the principal elements that make up the potable water system are treatment plants, aqueducts, regulatory tanks, pumping stations, and the primary distribution system. Figure 3-18 illustrates the system's main components.

A major part of the primary supply begins at the El Florido Water Treatment Plant (Section 2, subsection 2.4.1), located east of the current service area. This plant treats water from the Colorado River and water stored in the Abelardo L. Rodríguez Reservoir. It is located at an elevation of 800 feet (244 meters) above sea level and has a capacity of 91 mgd (4 m^3/s). Water flows from this plant by gravity and is distributed to two large areas, one on each side of the Tijuana River. Two major tanks dominate the area on the river's right bank; the Cerro Colorado Tank, 731 feet (223 meters) above sea level, with a capacity of 5.3 million gallons (20,000 m^3), and the Mesa de Otay Tank, 627 feet (191 meters) above sea level, also with a capacity of 5.3 million gallons (20,000 m^3). The Aguaje de la Tuna main tank dominates the area on the river's left bank. It stands at 715 feet (218 meters) above sea level and has a capacity of 7.9 million gallons (30,000 m^3). In addition to these major tanks, a network of regulating tanks is connected to the main aqueduct.

A second source of supply is the Abelardo L. Rodríguez Water Treatment Plant, located to the south of the service area. This plant, 246 feet (75 meters) above sea level, has a capacity of 14 mgd (600 l/s). It was originally designed to treat surface water that accumulated in the Abelardo L. Rodríguez Reservoir. However, due to inconsistent rainfall, this plant does not usually operate at its maximum capacity. Currently, during the winter when there is an excess of available water, the Colorado River Aqueduct supplies the Rodríguez Reservoir. The objective is to store water for eventual treatment at the Rodríguez plant during dry periods.

The water treated in the Rodriguez plant supplies Tijuana through a transmission main that is 30-inches (760 mm) in diameter. It crosses the city following the Tijuana River until it arrives at the Morelos Pumping Station, and from there it goes to Zona Centro and in extraordinary circumstances, to the Herrera Tank. That tank is the initial point of supply for Playas de Rosarito through the Herrera-Rosarito Aqueduct.

Another local water-supply source is a system of wells in the Río Tijuana, Playas de Rosarito, and La Misión areas (see Section 2, subsection 2.4.1). Most of the wells in Tijuana lie along the Tijuana River. The river's aquifer has quality issues, but a treatment plant is currently under construction to eliminate excessive concentrations of certain elements, such as iron and manganese.

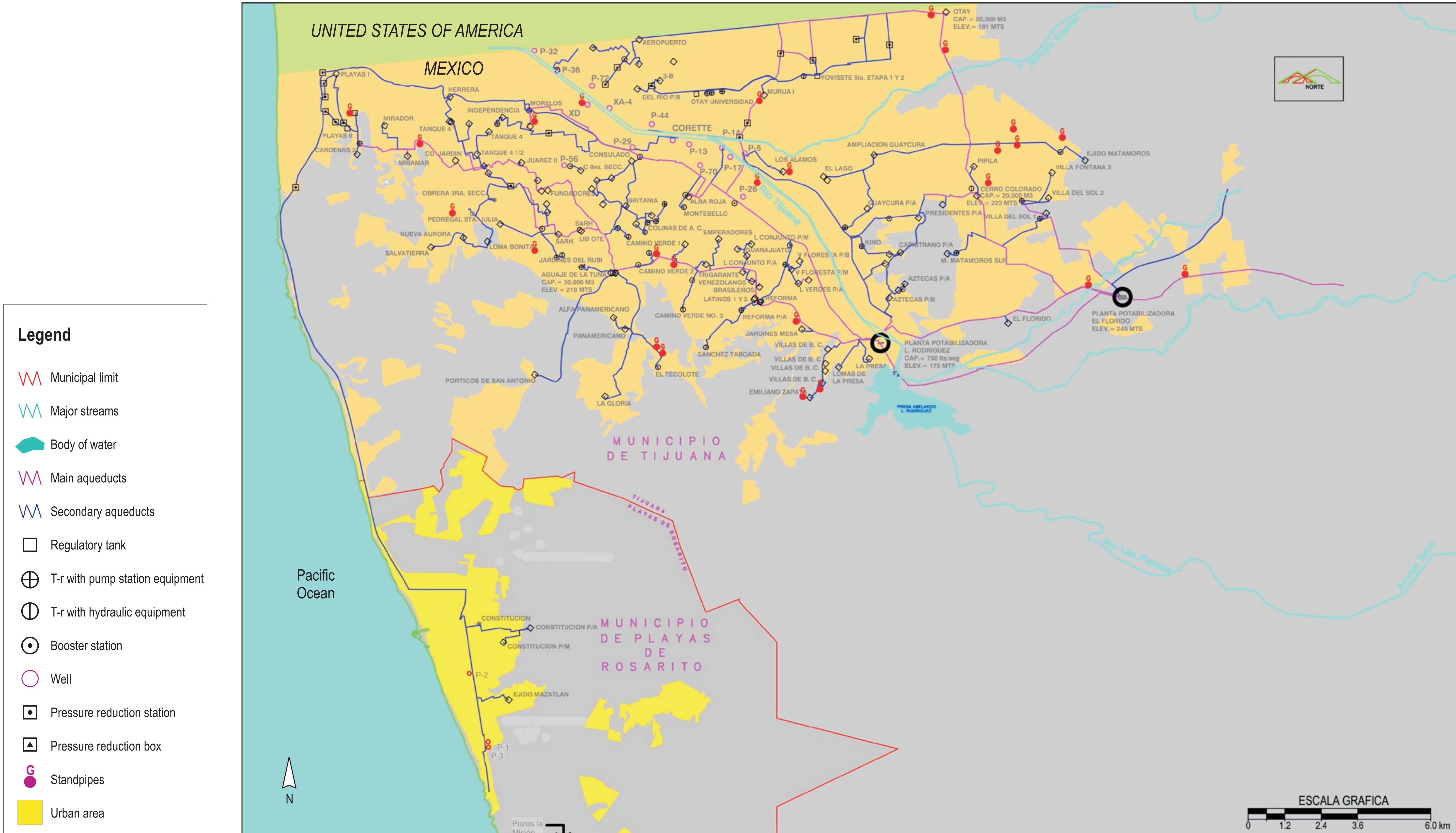


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Figure 3-18
Primary elements that conform the potable water network of Tijuana and Playas de Rosarito

In addition to the three aqueducts that supply water to Tijuana and Playas de Rosarito, there is an emergency connection with the United States 159 gal/s (600 l/s), 24-inch diameter (610 mm), which supplies northern Tijuana.

The distribution system consists of approximately 2,052 miles (3,302 km) of pipe, with diameters that vary between 1 and 54-inches (25 and 1372 mm), 174 regulating tanks with capacities between 0.01 and 0.79 million gallons (40 and 30,000 m^3), and 106 pumping and repumping stations, and 21 operating hydropneumatics of 26 in total (see Table I-5, Appendix I). Table 3-9 lists the installations that form part of the potable water system and their physical condition (2001).

Table 3-9
Potable Water System Installations

Installation	In Service	Out of Service	Repairs	Storage	Location Unknown	Withdrawn From service	Total
Potable water treatment plants	2	1	-	-	-	0	3
Pumping stations	7	2	-	-	-	0	9
Re-pumping stations	50	8	-	-	-	49	107
Hydropneumatics	26	1	-	-	-	13	40
Tanks	127	11	-	-	-	36	174
Wells	15	7	-	-	-	23	45
Pressure Reductors	116	20	-	-	-	12	148
Pressure Reducer Boxes	84	4	-	-	-	1	89
Measuring Stations	53	18	-	-	-	5	76
Chlorination Rooms	16	9	-	-	-	0	25
Electric Motors	242	88	-	248	-	10	588
Pumps	198	45	11	119	186	17	576
Control Valves	498	106	-	14	187	31	836
Macrometers	113	34	9	24	16	22	218
Chlorinators	21	7	-	-	7	0	35
Storage (E.B.)	3	-	-	-	-	1	4

Source: Department of Operational Control (Catastro de Instalaciones, 2001, CESPT).

The potable water system is operated manually as well as by telemetry. Hourly measurements of the water levels are taken manually in the high-capacity regulating tanks and are communicated to personnel at El Florido Water Treatment Plant, who adjust the flow based on demand. The treatment plant's operation is based strictly on the system's demand for water, and it is not controlled by an explicit operating regimen.

The telemetry operation automatically controls the levels of certain tanks, the water treatment plant, and pumping stations. Appendix E lists the structures connected to the telemetry system.

Because of the uneven topography, the pressure exceeds the established regulatory range 20 psi to 70 psi at certain locations. Release valves and pressure reducers control the pressure in the system.

Distribution System

The distribution system in the northern and central areas of Tijuana was built approximately 50 years ago, making it the oldest in the study area. Table 3-10 lists the period, size, and area installation for pipes in Tijuana and Playas de Rosarito (Figure 3-12).

Table 3-10
Period and Expanse of Pipe Installation

Period	Hectares	Acres
1948-1960	652	1,611
1966-1970	2,882	7,122
1671-1975	1,066	2,634
1976-1980	1,277	3,156
1981-1985	908	2,244
1986-1990	1,601	3,956
1991-1995	3,302	8,159
1996-2000	2,880	7,117
2001	100	247
Undefined period	2,736	6,760
Total	**17,404**	**43,006**

Source: Departamento de Control Operacional (Oficina de Hidrometría, 2001 CESPT)

A primary network and a distribution network make up the potable water system. The primary network is comprised of aqueducts and interconnection pipes, which include the pipes that connect the main regulating tanks with the treatment plants. The diameter of the pipes in the primary network ranges from 20- to 54-inches (508 mm to 1,372 mm). As Table 3-11 indicates, the primary network has almost 101 miles (162 km) of pipe, representing approximately 5 percent of all pipes in the potable water system.

Table 3-11 Potable Water Distribution System in Tijuana and Playas de Rosarito				
Diameter		Length		Percentage
Millimeters	Inches	Meters	Feet	
Primary Network – Transmission Mains				
1,372	54	18,868	61,903	0.57
1,219	48	19,563	64183	0.56
1,067	42	218	715	0.07
914	36	9,405	30,856	0.28
762	30	27,105	88,927	0.82
610	24	19,918	65,348	0.60
508	20	66,851	219,327	2.02
		161,928	531,258	4.92
Secondary Network – Distribution Pipes				
457	18	19,197	62,982	0.58
406	16	42,094	138,103	1.27
381	15	556	1,824	0.02
356	14	37,066	121,607	1.12
305	12	88,315	289,747	2.67
254	10	116,673	382,784	3.53
203	8	200,536	657,925	6.07
152	6	507,419	1,664,755	15.37
102	4	2,030,913	6,663,080	61.51
76	3	34,961	114,701	1.06
64	2.5	3,429	11,250	0.10
51	2	59,325	194,635	1.80
38	1.5	67	220	0.00
25	1	16	52	1
	Total	3,140,567	10,303,670	95.10
		3,302,495	**10,834,920**	**100**
Source: Departamento de Control Operacional (Catastro de Redes 1999, CESPT and Oficina de Catastro 2001, CESPT)				

Table 3-12 summarizes the diameters and lengths of pipes in the Tijuana-Playas de Rosarito Potable Water System.

Table 3-12 Water Distribution Lines – Length and Materials			
Material	Length		Percentage
	Meters	Feet	
Asbestos-Cement	1,515,588	4,972,387	45.93
Steel	34,788	114,134	1.05
Prestressed concrete	34,795	114,157	1.05
Cast iron	3,460	11,352	0.10
Fo.Fo	24,912	81,732	0.75
PVC	1,687,204	5,535,429	51.12
Total	**3,300,747**	**10,829,191**	**100.00**
Source: CESPT's Inventory, Departamento de Catastro, Agosto 2002.			

The distribution system consists of pipes smaller than 20-inches (508 mm) in diameter. This system is used to connect the smaller capacity tanks and to distribute water to service users. Table 3-11 shows the distribution system has approximately 1,952 miles (3,141 km) of pipe, or nearly 95 percent of all pipes in the system. Figure 3-19 shows the primary distribution network as well as its regulating tanks. The primary network forms part of the hydraulic model analysis presented in Section 8 of the master plan report.

Table 3-13 lists the type of pipe material currently used in the aqueduct and conveyance lines. It presents information for 1999 because information on pipes installed in 2000 and 2001 is unavailable. In 1999, the material most widely used in pipe construction was asbestos-cement (AC) and PVC. Today, CESPT uses predominantly PVC for pipes up to 24-inches (610 mm) in diameter and for replacement and directional boring (For major pipes steel or pre-tension concrete is used).

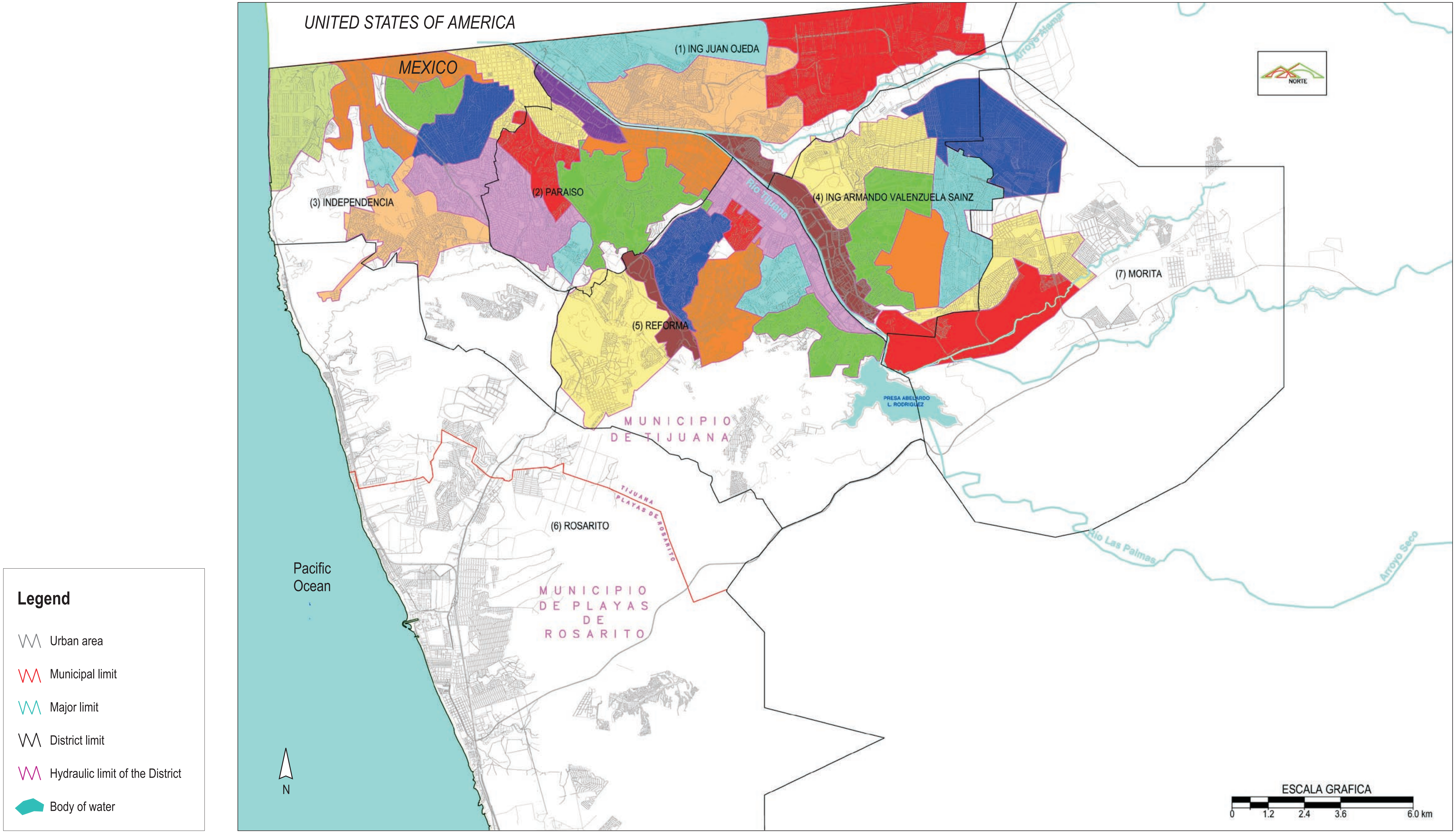

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Figure 3-19
Hydraulic Districts

Table 3-13 Aqueducts and Transmission Mains – Materials and Pipe Capacity						
Name	**Diameter**		**Length**		**Material**	**Capacity (l/s)**
	Millimeters	**Inches**	**Km**	**Miles**		
Florido-Aguaje	1,372	54	19.14	11.89	Reinforced Concrete	2,200
Aguaje Planetario	1,219	48	1.80	1.12	Reinforced Concrete	2,000
Las Ferias	508	20	1.22	0.76	PVC	536
	406	16	0.77	0.48	PVC	
	254	10	0.17	0.11	PVC	
	203	8	1.30	0.81	PVC	
Obrera Playas Stage 1	305	12	2.11	1.31	Steel	1,262
Obrera Plays Stage 2	762	30	3.89	2.42	Steel	450
	610	24	1.83	1.14	Steel	
	381	15	0.57	0.35	PVC	
	356	14	0.31	0.19	PVC	
	305	12	0.74	0.46	PVC	
Tank 4 ½ - Herrera Tank	610	24	1.56	0.97	Asbestos-Cement	576
	508	20	2.05	1.27	Asbestos-Cement	
	914	36	0.77	0.48	Reinforced Concrete	450
	1,067	42		0.00	Reinforced Concrete	
Insurgentes	508	20	8.00	4.97	Asbestos-Cement	228
Florido-Otay	1,219	48	9.05	5.62	Steel	2,026
	914	36	4.69	2.91	Steel	
Cerro Colorado Azteca	610	24	1.89	1.17	PVC	467
	508	20	1.05	0.65	PVC	
	356	14	1.65	1.03	PVC	
Cerro Colorado Azteca	406	16	2.05	1.27	PVC	
	610	24	0.62	0.39	Steel	
Guaycura – El Lago	508	20	1.40	0.87	PVC	395
	406	16	1.64	1.02	PVC	545
	305	12	1.94	1.21	PVC	198
Otay-Aeropuerto	914	36	2.69	1.67	Steel	1,511
	610	24	2.90	1.80	Asbestos-Cement, Techite	459
	508	20	4.60	2.86	PVC	225
Florido-Niño	508	20	6.84	4.25	PVC	310
Aqueducts and Lines with Pumps						
La Misión-Tijuana	508	20	1.10	0.68	PVC	250
	533	21	32.30	20.07	PVC	
	508	20	13.70	8.51	Asbestos-Cement	
	508	20	32.00	19.88	PVC	
Residencial Agua	203	8	0.21	0.13	Asbestos Cement	125

Table 3-13
Aqueducts and Transmission Mains – Materials and Pipe Capacity

Name	Diameter		Length		Material	Capacity (l/s)
	Millimeters	Inches	Km	Miles		
Caliente	305	12	0.77	0.48	Asbestos Cement	
Reforma-Sánchez Taboada	406	16	2.90	1.80	Steel	62
Aguaje-Panamericano	406	16	1.25	0.78	Ductile Concrete, Asbestos Cement	60
Obrera-Tanque Rubí	610	24	0.76	0.47	PVC	754
Tanque Rubí- Tanque 4 ½	762	30	4.37	2.72	Asbestos Cement	605

Source: Department of Operational Control (Catastro de Redes, 1999, CESPT)

Overall, there are 13 gravity lines and 6 pressurized lines with a total length of 111 miles (179 km).

Water-Storage Tanks

The water system includes a total of 174 water storage tanks. However, only 127 are currently operating. Of the out-of-service tanks, 11 could be operated, while 36 others are permanently removed from service. The tank capacities range from 10,500 gallons to 8.1 million gallons (40 to 30,000 m^3).

Water storage tanks can be placed in three categories, based on their capacity. The regulating tanks have a capacity of 1.2 to 8.1 million gallons (4,500 to 30,000 m^3); the primary tanks have a capacity of 0.3 to 1.2 million gallons (1,000 to 4,500 m^3); and the pressure-reducer tanks are those with less than 0.3 million gallons (1,000 m^3) capacity.

Two main aqueducts run from El Florido Water Treatment Plant into the distribution system. The Florido-Otay Aqueduct distributes water to the Ingeniero Juan Ojeda and Ingeniero Armando Valenzuela Sainz Districts and to the new Morita District, all of which are located on the right bank of the Tijuana River. The first delivery point for this aqueduct is the Cerro Colorado Regulating Tank with a capacity of 5.1 million gallons (20,000 m^3). From this tank, the aqueduct continues to the border where it enters the Otay Regulating Tank, which also has a capacity of 5.1 million gallons (20,000 m^3). From the Otay Tank, the aqueduct runs west, parallel to the border, until it reaches the Aeropuerto Tank, with a capacity of 1.3 million gallons (5,000 m^3). Other small tanks in the area are supplied from these three regulating tanks or directly from the aqueduct.

The second aqueduct, called Florido-Aguaje de La Tuna, feeds the Reforma, Paraíso, and Independencia Districts and part of the Rosarito District, all of which are located on the left bank of the Tijuana River. The Aguaje de la Tuna Regulating Tank with a capacity of 8.1 million gallons (30,000 m^3) is the main tank. The water from this tank flows through two aqueducts to two other areas. The first supplies the low-lying part of Tijuana (the Zona Centro, or downtown) and the second supplies the southwestern, or higher-elevation areas. The first aqueduct feeds the SARH Obrera 3ra Sección and Herrera Regulating Tanks, each with a capacity of 1.3 million gallons (5,000 m^3). The Herrera Tank supplies Playas de Rosarito through the Misión-Tijuana Aqueduct. The Panamericano and Pórticos de San Antonio Regulating Tanks, with capacities of 2.1 million gallons (8,000 m^3) and 0.8 million gallons (3,000 $m^{3)}$ respectively, supply the aqueduct that feeds the higher elevations in the city.

Figure 3-19 shows the location of the main regulating tanks in relation to the main aqueducts. Appendix F lists the regulating tanks and some of their characteristics. Table I-4, Appendix I, provides details on all CESPT tanks.

The water output is regulated by 127 functioning tanks, with an overall capacity of 71.6 million gallons (271,051 m^3). These tanks (Murua, Indeco, Pastejé, Padre Kino, Presidentes P/A, Florido III and Ejido Matamoros) have a combined capacity of 2.8 million gallons (10,600 m^3), and once they are renovated, the storage capacity will increase to 74.4 million gallons (281,685 m^3). Taking into account the capacity of the tanks under renovation, one can say that CESPT has a sufficient storage capacity to satisfy demand based on current SAHOPE regulations. There is a significant difference between the required storage capacity and existing capacity, which may indicate that tanks are being used to release pressure and not as regulating tanks.

While the existing overall regulation capacity exceeds the requirements of the SAHOPE regulatory rules, the additional capacity, if properly located and regulated, can provide many advantages to the operation of the system such as:

- Reduction in fluctuations in demand from the treatment plants;
- Stabilization of flow in the main aqueducts;
- Availability of additional regulating capacity in emergencies; and
- Availability of sufficient capacity to provide the pumping and re-pumping stations that supply the city's high elevation areas.

Nevertheless, the fact that overall regulation capacity exceeds the SAHOPE regulations does not mean that localized storage shortages do not exist. As part of the system's hydraulic model (see Section 8), areas will be identified that lack adequate storage capacity.

Some regulating tanks can supply larger service areas than those they currently supply. Similarly, there are cases in which the tank capacity is less than required for its service area, which implies that even when sufficient overall regulating capacity exists, it has been inadequately distributed.

Pumping Stations

The potable water system has three types of pump stations:

1. Pumping stations that send water from regulating tanks to supply a new system;

2. Re-pumping stations, located where the pressure in the system is insufficient to supply high-elevation areas, making additional in-series pumping necessary;

3. Hydropneumatic stations, which supply small areas around the distribution tanks when there are no tanks at a higher elevation.

The distribution system has seven pumping stations. The three primary ones are Obrera, Morelos, and Reforma. The Obrera Station has three 400 Hp pumps; two operate continuously and the third is in reserve. This station is currently being rehabilitated and it is expected to operate only when the Abelardo L. Rodríguez Reservoir has water. The Morelos Station has two 400 Hp pumps, one operating continuously and the other in reserve. The Reforma Station has three 200 Hp pumps; two operate continuously and the third is in reserve. In this last station, there are also two 60 Hp pumps, one operating and one in reserve. Overall, these three main pumping stations have a combined capacity of 2,720 Hp.

The remaining pumping stations are: the 550 Hp treatment plant station, located in the Ejido la Misión; the 9,000 Hp Plant No. 6, located on the Carretera Libre Tijuana–Mexicali in the community of La Presa; the 800 Hp Cortina de la Presa Plant located on the Tijuana-Tecate highway, in the community of La Presa; and the 150 Hp plant No. 2, located at the intersection of México and Rincón Streets.

The pumping stations have macrometers to determine the supply flow. However, they are inadequately maintained. Maintenance is performed only when there is a breakdown and replacement is necessary, or when they surpass their expected useful life.

Overall, there are 50 booster stations distributed throughout Tijuana and Playas de Rosarito, varying from 8 to 1,200 Hp, with a combined power estimated at 6,591 Hp.

The hydropneumatic stations that supply the areas adjacent to regulating tanks or unplanned and unregulated communities, where the service area is at a higher elevation in relation to the area's supply tanks. Normally, the hydropneumatic stations are small, and their equipment is limited to motors of about 15 Hp. The system has 26 hydropneumatic stations that vary in power from 3 to 15 Hp with a combined power of 429 Hp. Table I-5 of Appendix I gives details about the individual stations. One major problem with these installations is vandalism. In some cases, they have been dismantled or the fences protecting them have been removed.

Control Valves
Its function is in accord with the types of valves and are classified in two types: reducer and relief. These valves are located in the main or tributary pipes. There are 836 control valves, of which only 498 are operational.

The control valves are plagued by vandalism. In some *colonias* (neighborhoods), valves are tampered with to increase the water pressure. Another significant problem is lack of coordination among government entities, since the control valves are often covered when the streets are paved, making it difficult to reach them and operate them. Moreover, there is a general lack of preventive maintenance.

Macrometers
There are 218 macrometers installed at wells, small pump stations, tanks, pressure reducer stations, and aqueducts, of which only 113 are operational. CESPT offers preventative and corrective maintenance and the latter identifies the damaged part and replaces it, as well as revising the exactness of the micrometering with potable equipment.

Submeters (Customer water meters)
On a monthly average during 2001, there were 327,752 registered customer accounts. Of these, 290,278 (89 percent) had a customer water meter, of which only 273,315 (94 percent) were functioning.

Currently, CESPT lacks an ongoing renovation or maintenance program for customer meters. Nevertheless, there is a workshop that checks and calibrates meters that customers report as broken. When meter readers note a meter that is not functioning or when a meter surpasses its expected useful life, it is replaced.

Although CESPT does not have an ongoing calibration-and-maintenance program for its submeters, during 2001 it replaced 21,490 feet (6,550 meters) and installed 15,792 on unmetered connections. As part of this program, replacement of 7,000 customer meters is planned for 2002.

3.3.3 Identification of Water Losses

As indicated in Section 2, water output during 2001 was 27,674 million gallons (104.6 million m^3). During that period, the average volume billed by CESPT was 21,008 million gallons (80 million m^3), indicating 23.50 percent of the water output unaccounted for.

The unaccounted water loss can be categorized as physical and commercial losses. The physical losses are subdivided into visible and invisible leaks. Visible leaks, generally reported by users, occur mainly in the distribution mains, residential connections, tanks, valves, and meters. There are also leaks in installations and the spillage from main and secondary pipes during maintenance. The main causes of visible leakage are high pressure, internal and external corrosion of the pipes, and the poor quality of the materials employed.

Another point where leaks have been found is in wells that are out of service, where the return valve fails, letting water run from the system into the ground.

Commercial losses consist of water that is consumed at some point in the system but which is not measured with exactness. These losses are caused mainly by errors in meter reading, errors in billing, technical errors in operation, faulty customer meter measurements, clandestine outlets, and by the lack of customer meters.

To combat water loss, CESPT has developed new techniques to control leaks and has implemented specific programs, dividing the city into hydrometric districts, and in some districts these programs have been put into practice. The first Hydrometric District studied was that of Playas de Tijuana (Distrito Hidrométrico de Playas de Tijuana, DHPT).

Dividing the distribution system into hydrometric districts makes it possible to prioritize how best to serve each one. The highest priority is given to districts where water loss is greater and where it can be considerably reduced with a small investment. Low priority goes to the districts where losses are moderate and higher levels of investment would be required to reduce them. The service area is subdivided into 32 hydrometric districts, as illustrated in Figure 3-19.

Table 3-14 summarizes the losses (the difference between water output and water billed), reported in the CESPT study for the Playas de Tijuana district.

Table 3-14
Water Losses (2001)

Type of Loss	Estimated Quantity (m^3/month)	Percentage
Physical Loss		
Visible Leaks	6,480.00	2.23
Invisible Leaks	3,836.00	1.32
Commercial Loss		
Clandestine	826.32	0.28
Fixed Rates	139.2	0.05
Averages	1,063.37	0.37
Fraudulent Use (meter tampering)	167.76	0.06
Customer meters	1,292.88	0.45
Hydrants	297.16	0.10
Total of Identified Losses	14,102.69	4.85
Unidentified losses	41,389.31	14.25
Total loss	**55,492.00**	**19.10**

Source: Departamento de control operacional (Oficina de Hidrometría, 2001, CESPT).

As seen in Table 3-14, there was a 23.50 percent water loss overall.

Table 3-15 summarizes an analysis of unaccounted water losses during the past six year, with average monthly volumes.

Table 3-15
Water Losses

Output	Year					
	1996	1997	1998	1999	2000	2001
Output (thousand m^3/month)	7,014	7,583	7,640	8,423	8,429	8,765
Billed (thousand m^3/month)	5,201	5,470	5,706	6,091	6,258	6,684
Measured Volume (thousand m^3 /month)	4,374	4,763	4,359	4,619	4,679	5,884
Unmeasured Volume (%)	84	87	75	75	75	88
Unaccounted Water Loss (thousand m^3 /month)	1,813	2,114	1,933	2,332	2,172	2,081
Unaccounted Water Loss (%)	25.60	27.50	25.20	27.40	25.80	23.50

Source: Department of Micromedicion of the Sub-direction Commercial, CESPT, 2002.

Appendix H summarizes the main deficiencies in the potable water system.

3.3.4 Operation and Maintenance Practices

To operate and maintain the potable water system, CESPT relies on the Subdirection of the Operation and Maintenance Division (Sub-Dirección de Operación y Mantenimiento), which is divided into the Departments of System Maintenance, (Mantenimeiento de Redes), Operational Control (Control Operaciónal), Electromechanics (Electromecánica), and Potable Water (Agua Potable).

To increase the system's operational efficiency, the service area was divided into the seven operation and maintenance districts described above. The creation of districts has increased operational efficiency because each has its own organizational structure and personnel, which allow each district to better serve its customers. Since the formation of these districts, the period of time required to repair a leak has been considerably reduced. Currently, repairs occur within a maximum of twenty-four hours after the receipt of a report. The district personnel are responsible for maintaining the system; repairing leaks in the pipes, tanks, pipe access opening; installing pipes, valves, meters, and connections.

Activities are guided by operation and maintenance manuals describing the methods to follow. Table I-2, Appendix I, lists the manuals used by district personnel and the various CESPT departments and offices.

The Electromechanics Department (Departamento de ekectrinecua) is responsible for repairing and replacing existing equipment. Equipment is not checked according to a pre-established schedule, but instead, it is inspected and serviced when operators report a mechanical breakdown.

The Potable Water Department (Departamento de Agua Potable), inspects and maintains the regulating tanks. Normally, the regulating tanks are repaired and serviced according to an established schedule, although in some cases the budget is insufficient to service all the installations when they require it. Moreover, the vandalism to which the tanks are subjected makes it impossible to keep these installations in good repair.

Each operating district has its own monthly inspection of repaired or replaced sections of pipe. This information is provided to the Department of Land Registry (Departamento de Catastro), so that it can be entered into the database.

There is no established maintenance program for the Potable Water System, and maintenance is performed only to correct problems.

No fixed schedule exists for cleaning the valve boxes. Instead, cleaning occurs only when it is necessary to section the pipes to repair leaks. In many cases, because documentation is lacking or the valves have been paved over, valve boxes cannot be located.

CESPT audits the overall volume extracted from all existing standpipes in the city to supply the water trucks. Nevertheless, there is no control over how many trucks go to each standpipe or what volume is delivered to each truck.

Cleaning of pipes clogged with sediments occurs only when customers complain. These problems arise most often after the repair of a leak, the installation of a new connection, or the replacement of a line since at these times dirt enters the system or the pipes may not have been cleaned prior to installation.

A major problem that district administrators face is lack of personnel as well as budgetary shortages for system maintenance. There is also insufficient and inadequate material to perform operational and maintenance tasks, as well as lack of storage inventory and it is imperative that a Committee is created to purchase the materials.

In 1999, the CESPT Department of Land Registry (Departemento de Catastio), began a program to create a database of all components of both the potable water and the sewer systems. To achieve this objective, the area served was divided into four zones, and GIS was used to digitize the components. Independent consultants in each of the four zones performed the infrastructure surveys and digitized the data. Coordination problems among the consultants and CESPT resulted in a failure to standardize the final product across the different zones, especially along their borders. CESPT has begun an effort to unify the four systems.

3.3.5 Procedural Framework

This section describes the procedures to determine when to supply service to new *colonias* (neighborhoods) or developments.

In *colonias (*neighborhoods) that are legalized or are being legalized, residents normally request service from CESPT, which then investigates the technical feasibility of supplying service from some point in the system or from a regulating tank. Upon approval of the technical feasibility, a topographic survey is conducted to develop accurate planimetry and information on terrain characteristics. The next step is to design the project and set a budget to determine if CESPT has sufficient funds for its construction. To carry out the work, it is also necessary to rely on political and social programs established by the municipal, state, and federal governments, which determine when and to which *colonias* (neighborhoods) to supply service.

In selecting the points of delivery to subdivisions and newly created *colonias* (neighborhoods), a technical brief is prepared to verify the existence of sufficient pressure and water. The developer is then shown an appropriate location for the connection, which CESPT personnel then install. Before the developer receives approval for the connection, the Operation and Maintenance Office (Sub-dirección Operación y Mantenimiente) reviews the project. Similarly, CESPT requests official documents authorized by other institutions, such as the city's Urban Development Department (Desarrollo Urbano del Municipio) in regards to approval of an urban project, land use planning, general site survey, etc.

In the past, other entities, especially SAHOPE, worked together with CESPT to determine the feasibility of providing service. To achieve this, periodic meetings and urban information workshops were held. Companies such as TELNOR (telephone company) , the gas company, and others attended and discussed specific problems. Currently, meetings have been held and agreements made with National Water Commission (Comisíon Nacional del Agua, CNA), SAHOPE, and State Water Commission (Comisión del Estado de Ambiental, COSAE), but these are not legally binding in court.

The rules or regulations that SAHOPE issued in December 1997 for the development of projects apply to the provision of water. Both the developer and CESPT must follow these rules and meet the specifications for pipes, pressure, and so forth. The law that regulates the provision of drinking water, published by SAHOPE in the Official Newsletter of the State of Baja California (*Diario Oficial del Estado de Baja California*) on November 19969.

CESPT does not have an ongoing program to expand the system. Instead, it expands based on the demand for service and availability of funds. The only programs that CESPT considers permanent are those for renovation of potable water pipes, meter installation, programs for control, detection of leaks, and clandestine outlets.

3.3.6 Shortcomings in the Potable Water System

The main shortcomings in the potable water system are summarized in Appendix H.

3.3.7 Current and Planned Projects

This section lists the projects under construction or that will be built during the first stage of the planning period. These also will be discussed in Section 6 (Task F), which considers alternative infrastructure proposals.

The short-term potable water projects are part of the Japanese Credit project, which attempts to increase potable water service coverage. Under this framework, 16 projects will be built benefiting more than 165,000 residents. More than 280 miles (450 km) of primary and secondary pipe will be laid to serve more than 35,000 residential connections. It is hoped that these projects will achieve 97 percent coverage of Tijuana and Playas de Rosarito.

Additionally, other projects are planned to help improve the general functioning of the system and to increase to some degree the capacity to deliver water to the population. The projects that have been identified are:

- The full exploitation of the aquifer for the Río Tijuana Wells.
- Expansion of the Colorado River-Tijuana Aqueduct by 30 mgd (1.3 m^3/s).
- Program to control leakage.
- Program for recovery of overdue accounts.
- Delivery of water from the United States to Mexico.
- Interconnection of the aqueduct on both sides of the Tijuana River.
- Sistema Rosarito II, which consists of constructing a new transmission main to carry water to new developments in Playas de Rosarito.

In addition to the projects listed above, some subdivision developers are implementing potable water projects, including the expansion of the second chamber of El Florido Tank in the Ing. Armando Valenzuela District. Table I-3, Appendix I, shows the Japanese Credit 2002 projects in progress and those that are planned for 2003.

3.4 Sewer System

3.4.1 General Description

In 2001, the wastewater collection system for Tijuana and Playas de Rosarito served a population of approximately 1,088,000 residents, the equivalent of 79 percent of the population in the study area that year.

The system consists of sewer laterals, subcollectors, collectors, interceptors, sewage lift stations, and major pumping stations. The wastewater collected by the system flows to the wastewater treatment plants, which are described in greater detail in

Section 3.5. Two main wastewater treatment plants serve Tijuana: the South Bay International Wastewater Treatment Plant, or SBIWTP, located in San Diego, California, and the San Antonio de Los Buenos Wastewater Treatment Plant, located west of Tijuana. A plant also exists in Playas de Rosarito to treat Rosarito's wastewater.

Most of the area served by the sewer system is located within the Tijuana River Basin, which covers most of the city and extends into the United States, ultimately discharging into the Pacific Ocean south of San Diego. The topography of Tijuana causes most of the wastewater to follow a natural course into the Tijuana River and beyond into the United States. Nevertheless, several public works intercept part of the wastewater flow in Mexican territory, ultimately sending it to the wastewater treatment plant.

Part of the wastewater generated in Tijuana, approximately 25 mgd (1,100 l/s), flows toward the United States, for its treatment at the SBIWTP. The treated wastewater is discharged into the Pacific Ocean through an ocean outfall.

The wastewater generated in areas of the city outside the Tijuana River Basin flows in a natural course to the Pacific Ocean within Mexican territory. Part of these waters are also treated before being discharged into the ocean. Playas de Rosarito, San Antonio del Mar, and Puerto Nuevo have small treatment plants.

Figure 3-20 shows the major sewer and treatment infrastructure in the study area, both within and outside the Tijuana River Basin.

Most of the collection system pipes have surpassed their expected useful life, and they are full of debris, which reduces conveyance capacity. Work has recently begun on projects to expand the system to areas that lack service, as well as to clean and rehabilitate sewer line and to construct a new transmission main to the San Antonio de Los Buenos Wastewater Treatment Plant parallel to the existing main.

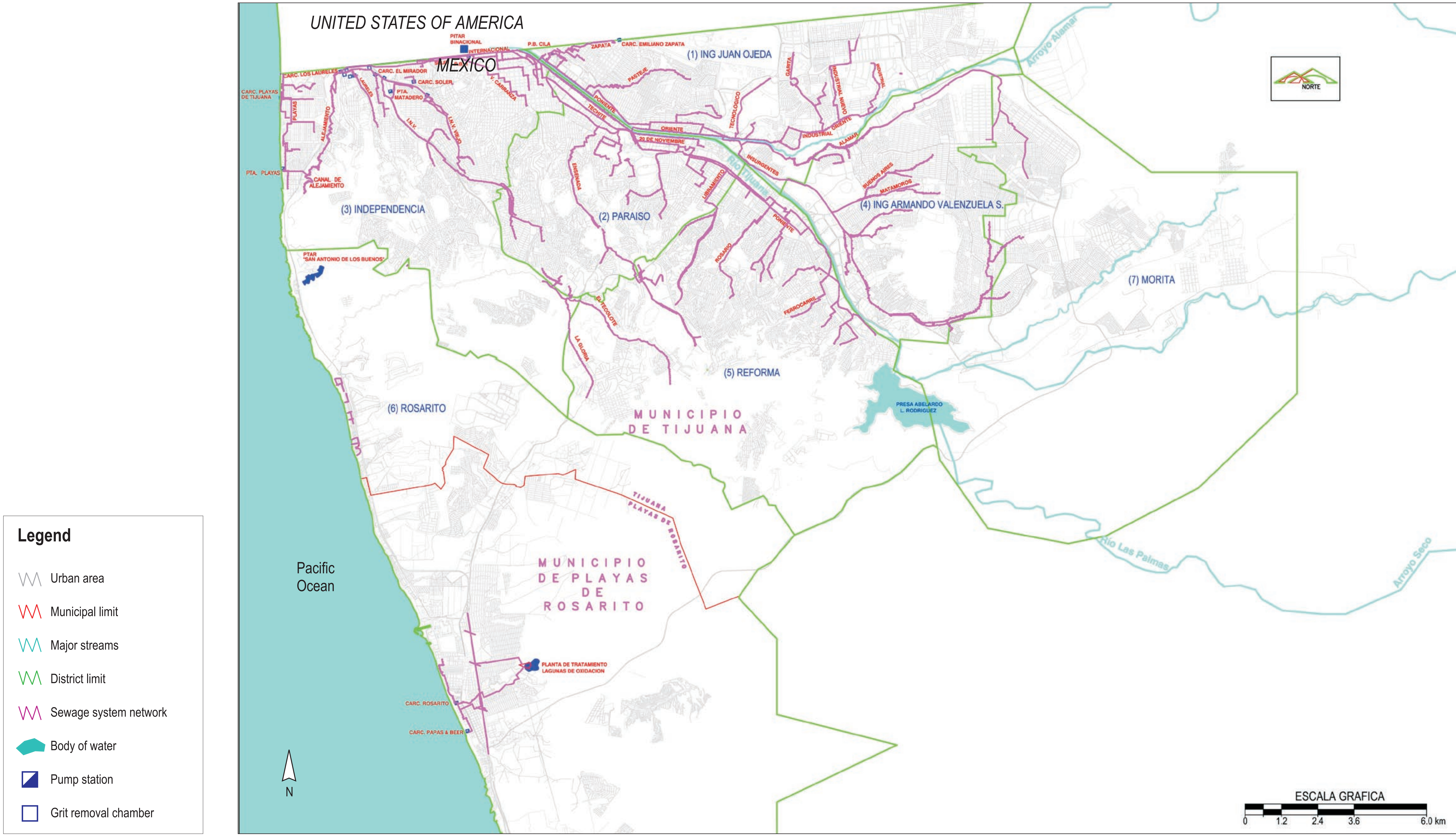

Figure 3-20
Pipe system that conforms the primary sewage system network of Tijuana y Playas de Rosarito